INSTRUCTION MANUAL — PART FOUR

for

MODEL LTU-3 RF TUNING UNIT

(4460 Mc-16,520 Mc)

PART OF MODEL LSA

ALL BAND, DIRECT READING

SPECTRUM ANALYZER

POLARAD ELECTRONICS CORP.

100 METROPOLITAN AVE.
BROOKLYN 11, N. Y.
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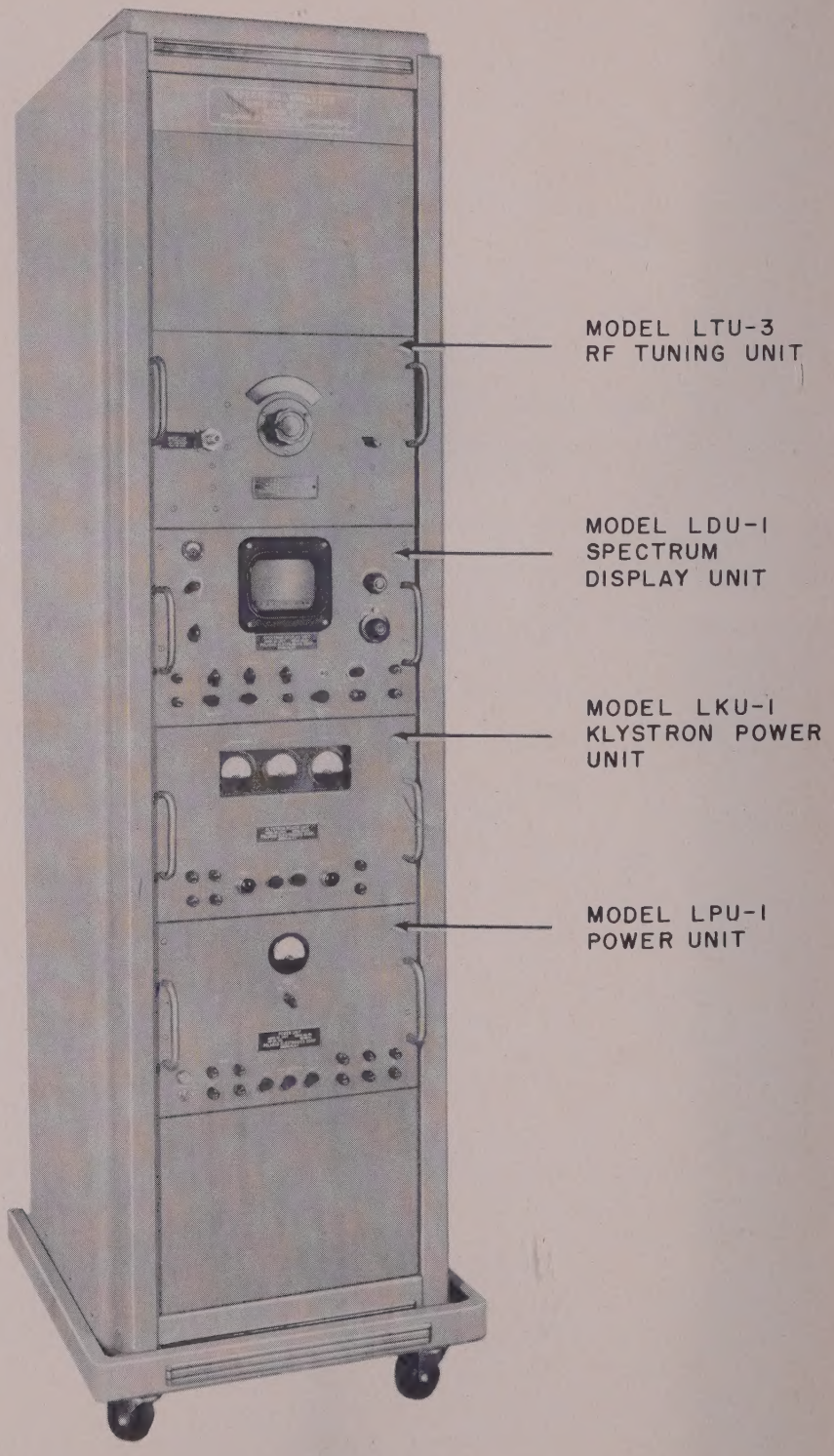


FIGURE 1. FRONT VIEW OF POLARAD MODEL LSA SPECTRUM ANALYZER, SHOWING BASIC UNITS AND ONE R-F TUNING UNIT.

PART IV

MODEL LTU-3

RF TUNING UNIT

(4460 Mc - 16,520 Mc)

SECTION I

GENERAL DESCRIPTION

1. PURPOSE AND ORGANIZATION OF MANUAL.

a. This instruction manual relates to the Model LTU-3 RF Tuning Unit, which is a part of the Model LSA All-band Direct-reading Spectrum Analyzer, designed and manufactured by the Polarad Electronics Corporation of Brooklyn, N. Y. (See fig. 1). The manual describes the electrical and mechanical features of the RF Tuning Unit covering the frequency range from 4460 Mc to 16,520 Mc, so that the equipment may be used intelligently and maintained at peak performance.

b. Since the Model LSA Spectrum Analyzer consists of several major units, it has been found desirable to divide the book into four major parts, to provide the most concise organization and presentation of the material. Part I contains descriptive and maintenance data for the basic units of the Spectrum Analyzer, which consist of the Model LDU-1 Display Unit, the Model LPU-1 Power Unit, and the Model LKU-1 Klystron Power Unit. Part II of the manual provides complete operational and adjustment data for the Model LTU-1 RF Tuning Unit, covering the frequency range from 9.5 Mc to 1200 Mc. Part III is an operating and service manual for the Model LTU-2 RF Tuning Unit, covering the frequency range from 940 Mc to 4500 Mc, while the present manual, Part IV, is applicable to the Model LTU-3 RF Tuning Unit only.

2. PURPOSE OF THE SPECTRUM ANALYZER.

a. Polarad's Model LSA Spectrum Analyzer is a laboratory instrument which is used to provide a visual indication of the frequency distribution of energy in an r-f signal in the range covered by the Tuning Unit in use. With the Model LTU-3 RF Tuning Unit connected to the basic units, radio signals in the frequency range from 4460 Mcs to 16,520 Mcs are converted to an intermediate frequency of 160 Mcs, at a power level sufficient to drive the various i-f circuits located within the Model LDU-1 Display Unit. Signals received and detected by this Tuning Unit are presented visually as a plot of voltage (or power), on the vertical axis, versus frequency, on the horizontal axis, of the oscilloscope within the Display Unit. Controls are provided on the Display Unit front panel for observing on the cathode-ray tube screen a band of frequencies as narrow as 250 Kc, adjustable continuously to a band as wide as 25 Mc, as desired.

b. Specific applications of the Spectrum Analyzer consist of:

(1) Observing and measuring the sidebands associated with amplitude and frequency-modulated signals;

(2) Determining the presence and accurately measuring the frequency of radio and/or radar signals;

(3) Checking the spectrum of magnetron oscillators;

(4) Measuring noise spectra;

(5) Checking and observing the tracking of r-f components of a radar system;

(6) Comparing two r-f signals differing by a small frequency separation.

3. EQUIPMENT SUPPLIED.

Figure 1 shows the Model LTU-3 RF Tuning Unit in operation with the basic units of the Spectrum Analyzer, all mounted within the deluxe steel test-rack type cabinet. Viewed from the top of the rack to the bottom, the units consist of the Model LTU-3 RF Tuning Unit (covering the frequency range from 4460 Mc to 16,520 Mc), the Model LDU-1 Display Unit, the Model LKU-1 Klystron Power Unit, and the Model LPU-1 Power Unit. The equipment supplied with the Model LTU-3 RF Tuning Unit is listed in Table 1, below.

TABLE 1. EQUIPMENT SUPPLIED

Polarad Model No.	Item	Description
LTU-3	RF Tuning Unit (4460 Mc - 16,520 Mc Range)	Mounted on rack panel, 12½" high, 19" wide, and 21-3/4" deep.
SIJ-2100	External RF Attenuator	Micrometer adjusted waveguide beyond cut-off attenuator.
....	Spanner Wrench	J. H. Williams, #482.
....	Splinehead Wrench	#6
....	Allen Wrench	1/4-28

4. ADDITIONAL ACCESSORIES.

The Model LTU-3 RF Tuning Unit is supplied with an external RF attenuator for use with signals in the frequency range from 4460 Mc to approximately 12,400 Mc (if at a power level of 1 milliwatt or greater). However, for signals in the range from about 12,400 Mc to 16,520 Mc, a waveguide attenuator and adaptor for connection to a type RG-91/U waveguide, or equivalent, are required.

5. ELECTRICAL CHARACTERISTICS, MODEL LTU-3 TUNING UNIT.

a. FREQUENCY CALIBRATION. -- The Model LTU-3 RF Tuning Unit tuning range is covered by means of two bands, both of which are inscribed on the calibrated tuning dial visible through the window at the top center of the front panel. The low band covers the frequency spectrum from 4460 Mc to 8500 Mc; the high band covers the spectrum from 8460 Mc to 16,520 Mc. The low and high band calibration marks are inscribed on the lower and upper sections of the tuning dial, respectively, as shown in figure 2.

b. OPERATING POWER REQUIREMENTS. -- Operating power for this tuning unit is supplied by two of the basic units of the Spectrum Analyzer equipment. The Model LPU-1 Power Unit supplies the 115-volt a-c power for the self-contained blower and transformer, (which develops the 6.3-volt a-c power for the heaters of the preamplifier tubes), and the positive 105-volt d-c potential for the plates and screen grid circuits of the preamplifier tubes. The Model LKU-1 Klystron Power Unit supplies the 6.3-volt a-c power, at 2 ampere current, for the heater of the reflex klystron tube, and the minus 1000-volt and 1600-volt potentials for the reflector and anode electrodes, respectively, of the reflex klystron tube.

6. PHYSICAL FEATURES.

The Model LTU-3 RF Tuning Unit contains an external cavity klystron local-oscillator, a crystal mixer, a 160 Mc preamplifier, a heater transformer and blower, both of which are protected by 1-ampere fuses in each input line, a tracking potentiometer adjustment panel, a CRYSTAL CURRENT LIMIT adjustment, and a mechanical drive system. The unit is tuned manually by rotating the single TUNING knob, located at the center of the front panel, which simultaneously drives a non-contacting choke within the oscillator cavity, a tracking potentiometer for changing reflector voltage automatically, and a tuning dial which indicates frequency in megacycles on either of its two calibrated scales accurately to better than 1%. The chassis and oscillator casting are secured by means of bolts and nuts to a front panel which is painted in a gray satin finish. Two handles, located at the two sides of the front panel, are provided for ease in pulling or replacing the Tuning Unit on its draw slides in the deluxe test rack supplied. At the rear of the unit are the two operating fuses, located within the extractor type fuseholders, the two spare fuses, and the panel receptacles for connection to the basic units. Refer to section II of this manual for a chart listing all controls, with their location and function.

7. TECHNICAL SUMMARY, MODEL LTU-3 RF TUNING UNIT.

Frequency range:	
Low	4460 Mc to 8500 Mc.
High	8460 Mc to 16,520 Mc.
Bandwidth	25 Mc.
Sensitivity	-95 dbw.
Tube complement	1-RK5721; 7-6AK5.
Power input:	
D.C.	+ 105v; - 1000 v; - 1600 v.
A.C.	6.3 v, 2 amperes; 115 v.
Tuning dial accuracy	Better than 1%.
Attenuation:	
R-F	110 db, external, continuously variable.
I-F	60 db, in 6 db steps.
Input impedance	50 ohms coaxial.

SECTION II

OPERATING INSTRUCTIONS

1. INTER-UNIT CABLING CONNECTIONS. (Refer to fig. 3).

a. Connect the Model LTU-3 RF Tuning Unit to the basic units of the Spectrum Analyzer as directed below:

(1) Connect inter-unit cable W2 from the Power Unit TUNING HEAD connector J2, on the equipment rear panel, to POWER receptacle J4001 on the tuning unit rear panel.

(2) Connect inter-unit cable W5 from the display Unit TUNING HEAD receptacle J302 to the DISPLAY receptacle J4002, on the tuning unit rear panel, right side.

(3) Connect inter-unit cable W4 from the Klystron Power Unit TUNING UNIT receptacle J101 to the KLYSTRON POWER receptacle J4003, on the tuning unit rear panel.

(4) Connect the signal under measurement to the type N adaptor, which is screwed on to the SIGNAL INPUT receptacle in the center left section of the tuning unit front panel.

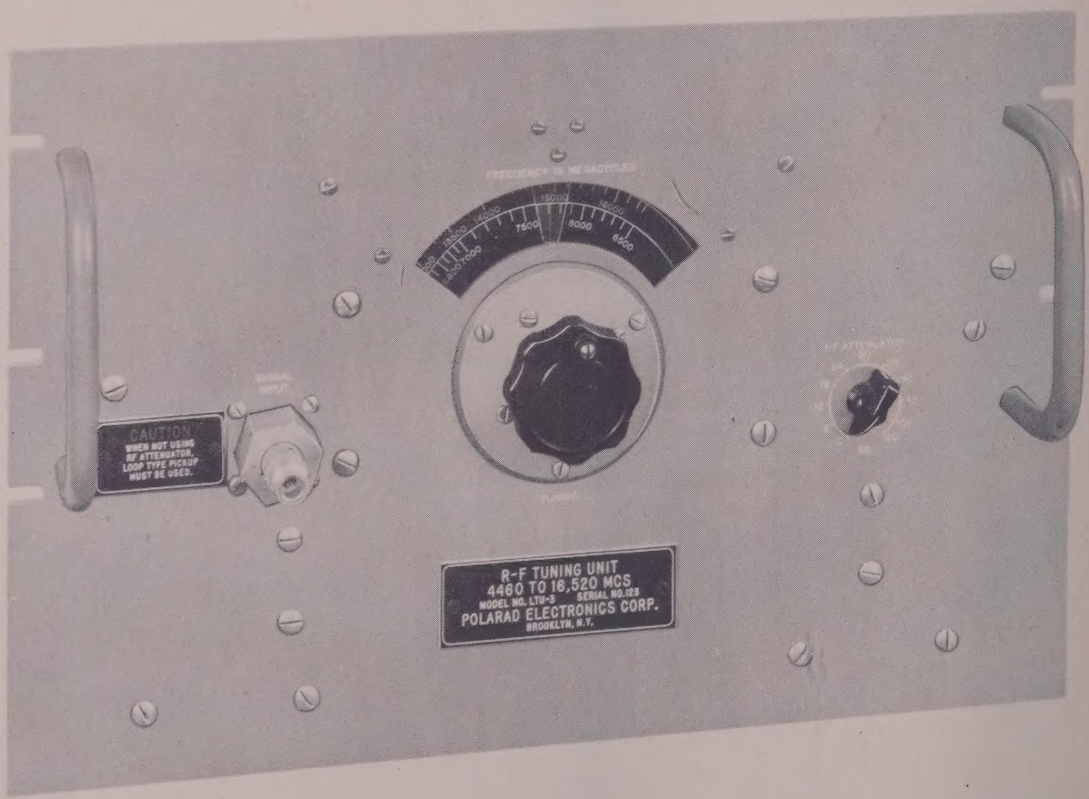


FIGURE 2. MODEL LTU-3 R-F TUNING UNIT, FRONT VIEW.

2. TABLE OF CONTROLS.

The following table lists the various operating controls located on the chassis. Locating and functioning information of each control and adjustment within the equipment is included.

TABLE 2. OPERATING CONTROLS AND ADJUSTMENTS

Control	Location	Function
TUNING	Center of the front panel.	(1) When rotated, this control changes the position of the choke assembly located within the oscillator cavity, thereby resonating the cavity to the desired 3/4-wavelength mode; and (2) Changes the position of the variable arm of the tracking potentiometer R4008, which determines the d-c voltage applied to the reflector electrode of the klystron tube at a particular tuning dial setting; and (3) Eliminates undesired 5/4-wavelength mode spurious oscillations; and (4) Drives the tuning dial, which is mounted on the same shaft as the variable arm of the reflector-electrode potentiometer.
I-F ATTENUATOR	Right section of the front panel.	Provides 60 db of attenuation, in nominal 6 db steps, control over the sensitivity of the Tuning Unit, by changing the cathode resistance of three tubes (V1302, V1303, V1304), comprising the first triplet in the 160-Mc preamplifier. A calibration curve for the particular unit accompanying this book will be found in Fig. 10.
INCREASE CATHODE CURRENT R4001	Reflector control board, rear of chassis.	Changes the bias potential applied to the control grid of the reflex klystron tube V4001.
HIGH LIMIT control R4002	Reflector control board, rear of chassis.	Sets maximum potential for tracking potentiometer at high end of the tuning range.

Control	Location	Function
LOW LIMIT control R4007	Reflector control board, rear of chassis.	Sets maximum potential for tracking potentiometer at low end of the tuning range.
TRACK 1 control R4006	Reflector control board, rear of chassis.	Sets proper value of tracking potentiometer at the 5000-Mc calibration mark on the tuning dial.
TRACK 2 control R4005	Reflector control board, rear of chassis.	Sets proper value of tracking potentiometer at the 5600-Mc calibration on the tuning dial.
TRACK 3 control R4004	Reflector control board, rear of chassis.	Sets proper value of tracking potentiometer at the 6300-Mc calibration mark on the tuning dial.
TRACK 4 control R4003	Reflector control board, rear of chassis.	Sets proper value of tracking potentiometer at the 7200-Mc calibration mark on the low band scale.
XTAL CURRENT LIMIT control R4020	Right section of chassis, directly in front of heater transformer, as viewed from front of equipment.	Sets maximum crystal current to 3 milliamperes.
No. 6 spline-head set screw	Top surface of trapezoidal shaped plate, to the right of the oscillator cavity, as viewed from front of equipment.	Locks the oscillator push-rod adjustment screw.
Oscillator push-rod adjustment screw.	Accessible through aperture at right side of trapezoidal shaped plate, to the right of the oscillator cavity.	Controls the initial setting of the oscillator cavity length.

3. STARTING PROCEDURE.

a. Be sure that all inter-unit cable connections are properly made. (Refer to par. 1 in this section, and to fig. 3).

b. Turn the POWER switch, located in the lower left section of the Model LPU-1 front panel, to its ON position, and allow a 10-minute warm-up period.

c. Check pointer deflections on the meters located on the Power Unit and Klystron Power Unit front panels, as described in Part I, Instruction Manual for the basic units.

d. Set controls on the Display Unit to produce a sweep base line, properly

located on the screen, as described in Part I, Instruction Manual for the basic units.

e. Set the I-F ATTENUATOR control to its zero setting.

4. OPERATING PROCEDURE.

a. To apply a low-power r-f signal to the Model LTU-3 RF Tuning Unit, feed the signal directly into SIGNAL INPUT receptacle on the equipment front panel. (The level of low-power signals that may be applied directly to the SIGNAL INPUT jack adaptor is 1 milliwatt or less).

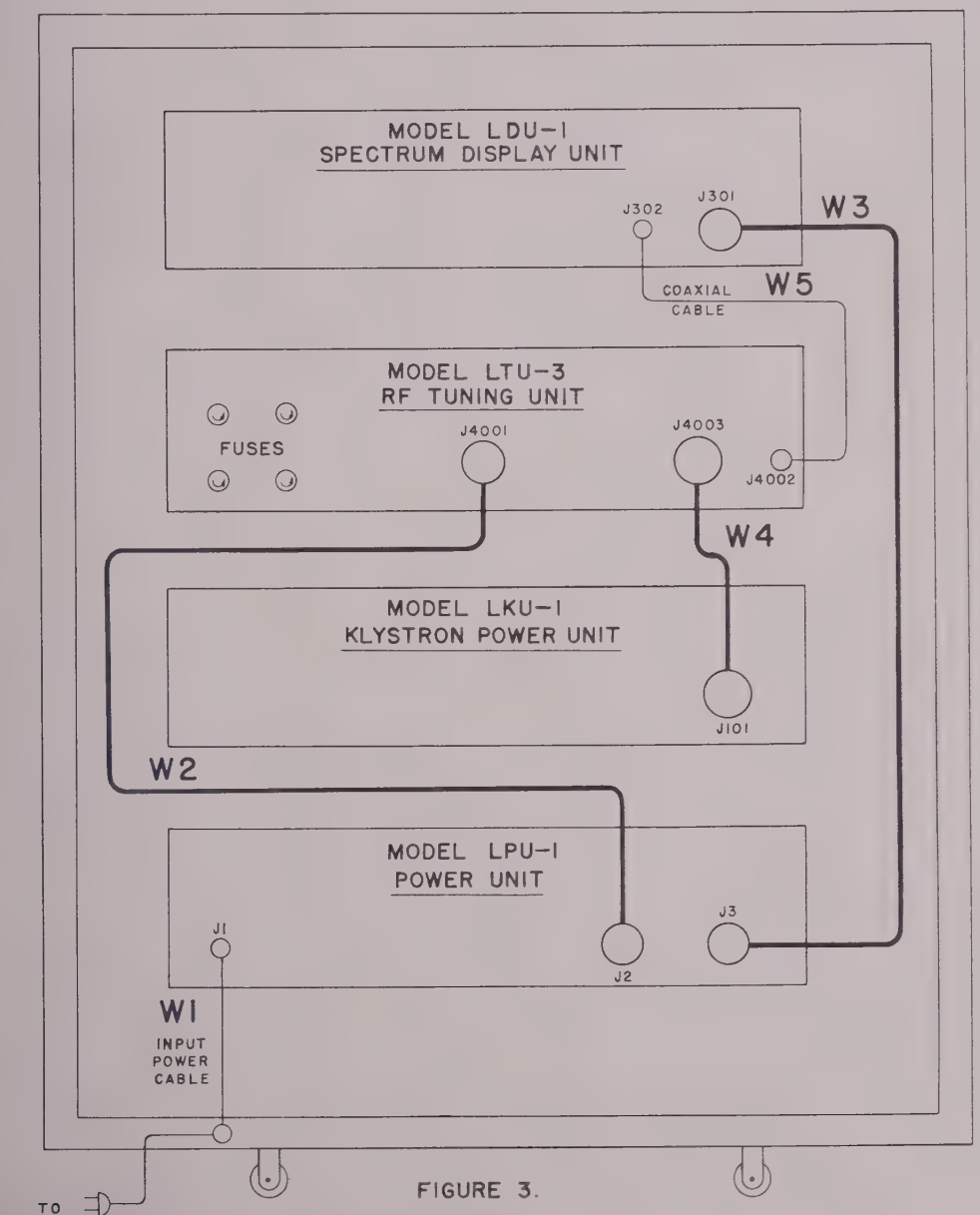


FIGURE 3.

MODEL LSA SPECTRUM ANALYZER, INTER-UNIT CABLING CONNECTIONS, FOR 4460 - 16,520 MCS. RECEPTION.

b. To apply a high-power r-f signal (power level greater than 1 milliwatt) to the Tuning Unit, connect the R-F ATTENUATOR, supplied with the equipment, between the signal source and the SIGNAL INPUT as directed below. (Refer to fig. 4).

(1) Apply r-f power from the signal source to the UG-20B/U connector which terminates the input coaxial line and tuning stub.

(2) Connect the output coaxial line, which incorporates the rotating barrel attenuator, to the SIGNAL INPUT jack on the Model LTU-3 Tuning Unit front panel.

(3) Set the scale for mid-scale indication. Check that the I-F ATTENUATOR control, located on the Tuning Unit front panel, is at its zero setting. An IF Attenuator table for the instrument accompanying this book will be found in Fig. 10, at the rear of this book. Reduce the attenuator scale setting until a complete pip, representing the detected r-f signal, is visible on the cathode-ray tube screen. (Refer to figure 5 for the R-F Attenuator calibration curve).

(4) Adjust the tuning stub on the R-F Attenuator until the signal pip appearing on the screen is at maximum amplitude. If the signal saturates the screen (that is, the top of the pip is not visible), rotate the I-F ATTENUATOR control one or more steps clockwise from its zero DB setting, until the entire pip is visible. Further control over the amplitude of the signal on the screen is obtained by backing off with the RF Attenuator scale. Always readjust the tuning stub for maximum height of the signal on the screen, after changing the scale setting.

c. No difficulty is presented in determining which of the two calibrated scales on the tuning dial is to be read in operating the equipment, since the upper-scale range is approximately twice the frequency of the lower-scale range. Signals above 12,400 Mc are normally carried by means of a waveguide. Therefore, only the high-band scale will be observed in operating the Model LTU-3 RF Tuning Unit with an RG-91/U (.391 x .702) waveguide. Further, signals in the higher band will appear to move across the Spectrum Display at twice the normal rate if they are read on the low-band scale.

5. OPERATING PRECAUTIONS.

a. For proper use of the Model LTU-3 RF Tuning Unit, it is essential that true signal pips and image-frequency pips be distinguished. Follow the directions given below to eliminate image-frequency pips from consideration:

(1) OPERATING OVER THE LOW BAND. -- In operating over the low range from 4460 Mc to 8500 Mc, apply a signal to the Tuning Unit and turn the TUNING knob until a pip appears on the screen. Then slowly tune the receiver up-scale. If the signal on the display screen moves towards the right, this is the true signal. Its frequency will then correspond to the appropriate tuning scale indication. If the signal moves towards the left, as the receiver is tuned up-scale, this is the image of the signal. The true signal will then be found 320 Mc lower than the image.

(2) OPERATING OVER THE HIGH BAND. -- In operating over the high range from 8460 Mc to 16,520 Mc, apply a signal to the Tuning Unit and turn the TUNING knob until a pip appears on the screen. Then slowly tune the receiver up-scale. If the signal on the display screen moves towards the left, this is the true signal. Its frequency will then correspond to the appropriate tuning scale indication. If the signal moves towards the right, as the receiver is tuned up-scale, this is the image of the signal. The true signal will then be found 320 Mc higher than the image signal on the tuning dial.

(3) Reference to the signal source will indicate approximately the range of signals applied to the Tuning Unit. The approximate frequency range of a magnetron, the spectrum of which is to be investigated, is known. A rule to be applied in operating the equipment throughout the low-band scale is that higher frequency signals appear at the left side of the display screen; therefore, in observing a detected signal move across the screen from left to right, the operator reads from a high-

frequency signal to a low-frequency signal. The converse of the rule applies in operating the equipment over the high-band scale. That is, higher frequency signals appear at the right side of the display screen; therefore, in observing a detected signal move across the screen from left to right, the operator reads from a low-frequency signal to a high-frequency signal.

b. The CRYSTAL CURRENT meter, located on the Display Unit front panel, is used as an indicator of klystron local-oscillator functioning. Any pointer deflection is an indication of klystron output. Disregard any numerical value of the calibrated scale, since the pointer deflection varies as the oscillator is tuned over the range of the Tuning Unit. If no pointer deflection occurs at a particular frequency setting, rotate the TUNING dial throughout its range. As long as the meter pointer deflects in some frequency settings, the equipment is functioning properly. The meter is relatively insensitive, and will not indicate low CRYSTAL CURRENT values. Trouble shooting of the equipment is required in the event that no CRYSTAL CURRENT meter indication is obtained and no signal output can be measured.

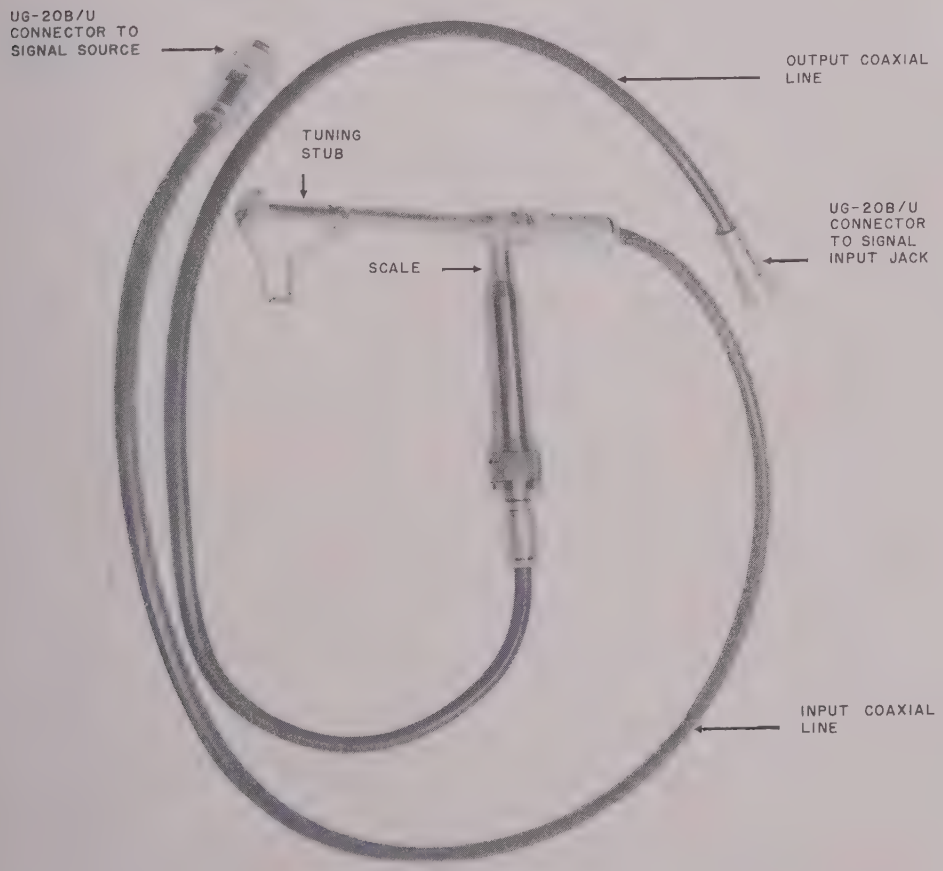


FIGURE 4. R-F ATTENUATOR.

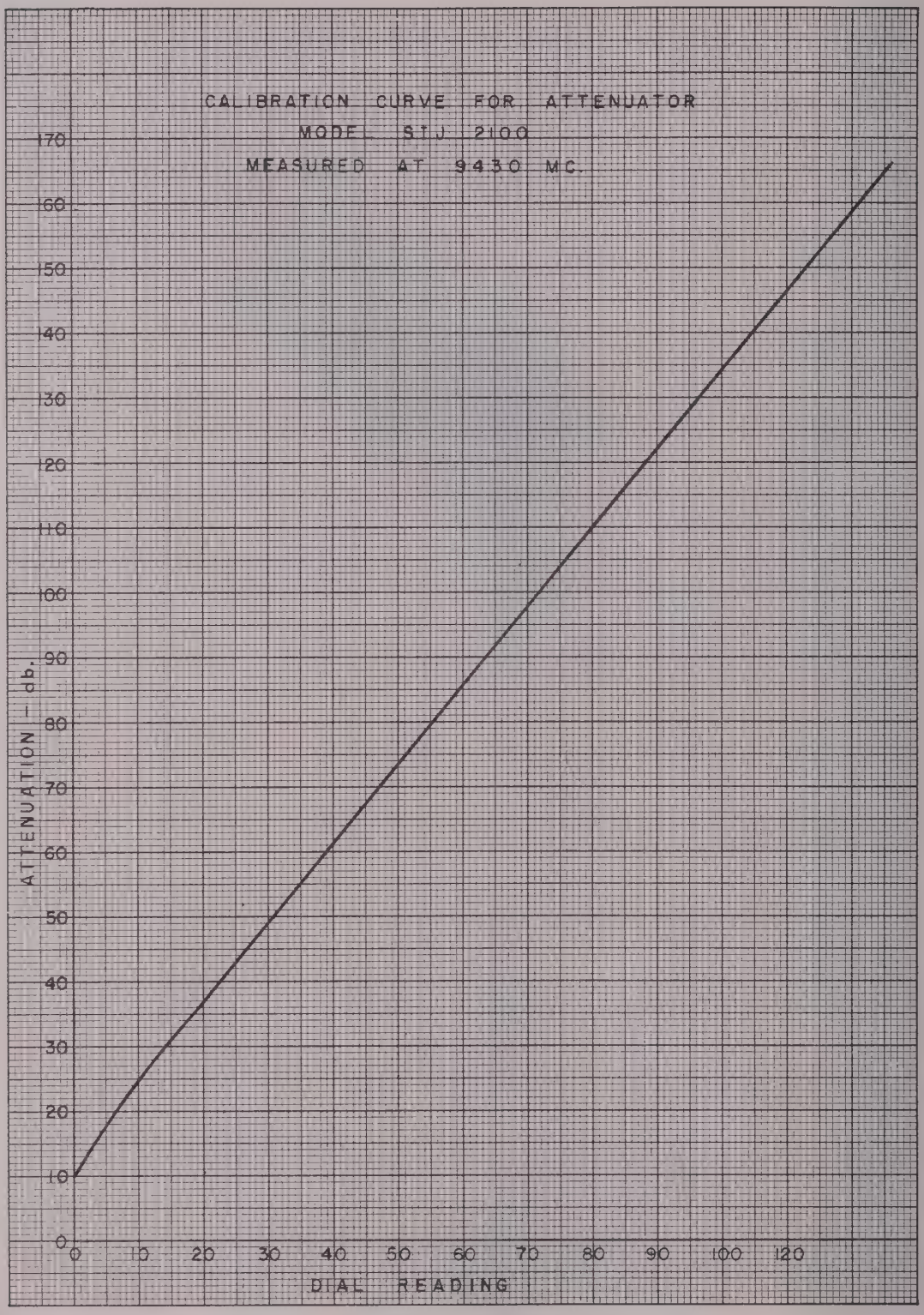


FIGURE 5. R-F ATTENUATOR CALIBRATION CURVE.

SECTION III

THEORY OF OPERATION

1. INTRODUCTION.

The Model LTU-3 Tuning Unit is one of three tuning units supplied with the Model LSA Spectrum Analyzer. This tuning unit receives signals in the range 4460 Mcs to 16,520 Mcs. The range is covered by two bands, with the lower-band scale calibrated from 4460 Mcs. to 8500 Mcs, and the higher-band calibrated from 8460 Mcs to 16,520 Mcs. By means of manual tuning, signals in a 25-Mc bandwidth, centered at the frequency to which the unit is tuned, are selected, and converted to 160 Mcs (the first intermediate frequency). The 160-Mc voltage is preamplified to improve signal-to-noise ratio, and is then fed by coaxial cable to the Display Unit. In the Display Unit, a second intermediate frequency of 64 Mcs is obtained by beating the 160 Mcs signal with the output of a sweeper circuit whose center frequency is 224 Mcs as it sweeps over the limits from 211.5 to 236.5 Mcs. Further in the Display Unit circuitry is a fixed-frequency 90-Mc oscillator which beats with the output of the 64-Mc narrow-band amplifier to produce a third beat frequency of 26 Mc. Converter stages produce additional i-f's of 5 Mcs, and finally 455 Kcs. This 455 Kcs signal is detected by a 12AT7 diode tube, the output of which is amplified and applied to the vertical plates of a display tube to appear as a pip, representing the power of the applied signal on the vertical axis, plotted against the band of frequencies covered by the output of the sweeper circuit on the horizontal axis. The following paragraphs 2 through 5 describe the major assemblies within the tuning unit.

2. DETAILED FUNCTIONING, KLYSTRON OSCILLATOR.

a. A type RK-5721 tube is employed as the first local-oscillator. In the lower band of operation (4460 Mc to 8500 Mc), the signal frequency is 160 Mc higher than the local-oscillator which oscillates over the range from 4300 Mc to 8340 Mc. In the higher band of operation (8460 Mc to 16,520 Mc), the second harmonic frequency of the local-oscillator is used in heterodyning with an incoming signal. In this band, the signal frequency is 160 Mc lower than the local-oscillator second harmonic frequency, which varies from 8620 Mc to 16,680 Mc.

b. The external cavity klystron oscillator in the present equipment functions in the (2,2) mode, with a 3/4 wavelength cavity mode and a 2-3/4 reflector mode. The oscillator is tuned by changing the position of a non-contacting short-circuiting choke assembly within the cavity. (Refer to figure 7). A mechanical pulley-and-cable system, described below, is used to drive the oscillator choke assembly (mounted at the end of the push-rod adjustment screw) as the TUNING dial is rotated. The voltage applied to the reflector electrode of the klystron tube is simultaneously tracked with the TUNING dial rotation by means of a tracking potentiometer, having four equally spaced taps. The voltage at each tap is maintained at proper level by a voltage-divider network, consisting of four potentiometers designated TRACK 1, TRACK 2, TRACK 3, TRACK 4. Two resonant stainless steel probes project into the cavity and are used to tune out the parasitic 5/4-wavelength oscillation, which normally occurs at the low-frequency end of the tuning range. These probes are varied in length automatically as the cavity is tuned.

c. MECHANICAL DRIVE SYSTEM. -- The drive system used in tuning the klystron-oscillator consists of a pair of pulley shafts, two lines of stainless steel cable, one push-plate, two hollow guide-rods, and one bearing block. When the TUNING knob is rotated, the drive-pulley shaft winds or unwinds (depending on the direction of rotation) the drive cable. This cable is connected to the first hollow guide-rod by means of a locking-nut and collet. The cable transmits TUNING knob motion through the guide-rod to the push-plate, which activates the choke-assembly push-rods of the oscillator. To prevent the push-plate from moving in a distorted path, a second guide-rod is attached to the plate. Both guide-rods are directed in their motion

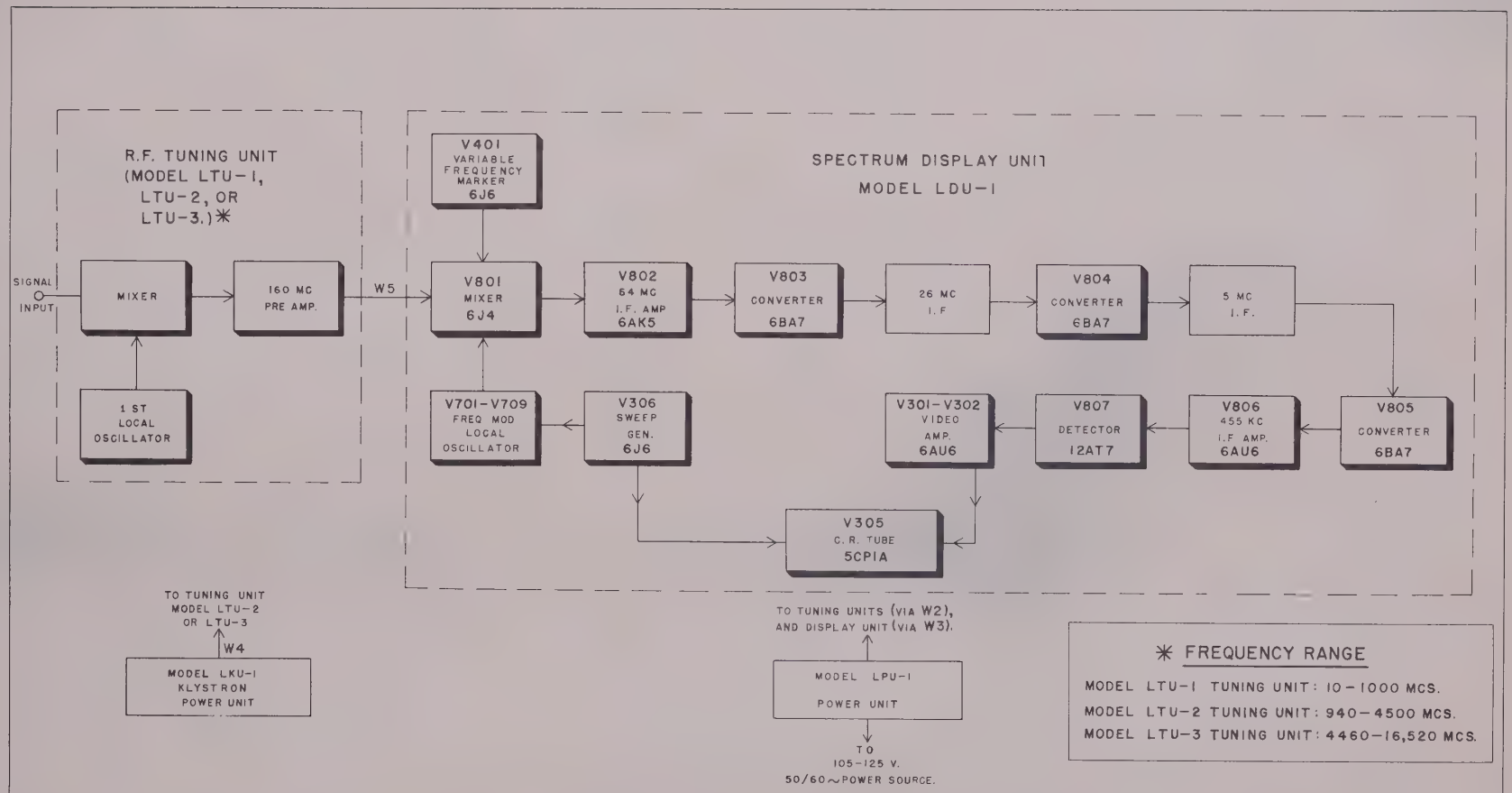


FIGURE 6.
MODEL LSA SPECTRUM ANALYZER,
FUNCTIONAL BLOCK DIAGRAM

Figure 7. Cross Section - Non-contacting Short.

by the bearing block, which is rigidly mounted to the main casting. The drive cable continues beyond its fastening through the hollow guide-rod and push-plate to a counter shaft, located at the right end of the casting (as viewed from the front of the equipment). A second line of stainless steel cable connects the two shafts in such a manner that when one cable winds, the other unwinds. This arrangement is required to obtain a positive driving action. A spring and turnbuckle in the second cable is used as an anti-backlash device. The push-plate, of trapezoidal shape (located to the right of the external oscillator-cavity), is linked directly to the non-contacting choke assembly, shown in cross-sectional view in figure 7. This linkage consists of two choke assembly push-rods, shown in figure 8. At their right ends, the push rods are terminated in a metal disc, which butts against a metal roller. As the TUNING knob is turned, the roller and the steel bar to which it is attached, moves and drives two cams at the left end of the bar. These cams are associated with the tracking of the 5/4-wavelength mode suppressors.

3. DETAILED FUNCTIONING, CRYSTAL MIXER.

a. A type 1N26 silicon diode is employed as the crystal mixer, which develops a beat signal of 160 Mcs when the fundamental frequency of the klystron oscillator and the applied signal in the low-band range of the tuning unit are coupled to its input. For example, when an r-f signal of 4460 Mcs is applied through the SIGNAL INPUT Jack to the crystal mixer, the klystron-oscillator is tuned to produce an output voltage of 4300 Mcs. The resultant difference frequency of 160 Mcs at the output of the crystal mixer is coupled, by coaxial cable, to the input stage of a stagger-tuned i.f. preamplifier. The 160-Mc voltage is amplified in this circuit to a level suitable for the mixing and amplifying functions performed by the I-F circuits in the Model LDU-1 Display Unit.

b. In operating the Tuning Unit over its high-band range, the second harmonic of the klystron-oscillator frequency is used to beat with the incoming r-f signal. This second harmonic component is actually developed in the crystal mixer CR4001, due to the mixer's non-linear characteristics. For example, when the Tuning Unit is tuned to a signal frequency of 10,000 Mc, the fundamental local-oscillator frequency is 5080 Mc. The second harmonic of the oscillator frequency is then 10,160 Mc. This second harmonic component beats with an incoming 10,000 Mc signal to produce a difference frequency of 160 Mc, which is fed to the preamplifier.

4. DETAILED FUNCTIONING, PREAMPLIFIER.

The i-f preamplifier receives signals from the crystal mixer at a frequency of 160 Mcs, and amplifies them to such a level that they may be transmitted through coaxial cable to the Spectrum Display Unit without introducing additional noise. The preamplifier amplifies signals in a band 28-Mcs wide, centered at 160 Mcs. It contains seven type JAN-6AK5 tubes. The first tube V1301 acts as an impedance transformer, matching the input of the preamplifier to the 91-ohm RG-71/U cable W4002

that transmits the signals present in the output of the crystal mixer. Tubes V1302 through V1304 comprise a stagger-tuned triplet, while tubes V1305 through V1307 make up the second triplet. The first stage in each triplet is tuned to the center of the pass-band at 160 Mcs, the second stage is tuned to 175 Mcs, and the final stage is tuned to 146 Mcs. The IF ATTENUATOR control varies the cathode impedance of the first triplet. Ten 6 db steps of i-f attenuation, ranging from 0 to 60 DB, are provided to control the sensitivity of the receiver.

5. POWER SUPPLY CIRCUIT.

a. Operating power for the Tuning Unit is obtained from the Power Unit and Klystron Power Unit by inter-unit cabling connections to POWER receptacle J4001 and KLYSTRON POWER receptacle J4003. The Klystron Power Unit furnishes all necessary voltages for the klystron tube operation. The Power Unit furnishes the positive 105-volt potential for the plate and screen grids of the JAN-6AK5 amplifiers in addition to 115-volt a-c power for heater transformer T4001 and blower motor B4001, and passes 115-v a-c on to power the Klystron Power Unit, Model LKU-1.

b. The a-c powered blower is located at the left bottom side of the oscillator casting, as viewed from the front of the equipment, and provides a constant stream of air to cool the klystron. The heater transformer T4001, is mounted on the chassis main frame, to the right and rear of the reflector adjustment control panel. Directly in front of the heater transformer is the screwdriver-adjusted shaft of the CRYSTAL CURRENT LIMIT control R4020. (Refer to section IV for adjustment procedure). The 6.3-volt a-c output from the transformer is used as heater power for the 7 tubes in the 160-Mc preamplifier, and for pilot lamps E4001 and E4002, which illuminate the tuning dial when power is applied.

SECTION IV

MAINTENANCE

1. GENERAL.

a. This section covers corrective maintenance for the Model LTU-3 RF Tuning Unit. Included are instructions for replacing the klystron oscillator tube and the alignment procedure required after installing a new klystron tube.

b. The material contained in this section is to be used in conjunction with the schematic circuit diagram appearing at the rear of this manual. Specific reference to this diagram is made throughout the text, where applicable.

2. PRE-OPERATIONAL CHECKS AND ADJUSTMENTS.
(Refer to figure 8.)

a. The Instruction Manual, Part I, for the Model LSA Spectrum Analyzer gives complete pre-operational checks and adjustment procedures for the basic units. The following directions apply to the Model LTU-3 (4460-to-16,520 Mc) Tuning Unit only, and should be performed after all checks and adjustments to the basic units are completed:

(1) Examine all tubes in the 160 Mcs preamplifier to see that they are firmly seated in their tube sockets.

(2) Check that switch action of the I-F ATTENUATOR S3001 is firm and positive for each of its 11 positions. Set the I-F ATTENUATOR to its 0 DB position, after performing the check.

(3) Check that rotation of TUNING knob throughout its range in both clockwise and counterclockwise rotation is smooth and continuous; the knob must be tight on its shaft.

(4) Examine all plugs and connectors to see that they are firmly seated and screwed tight.

(5) With operating power OFF, check that the klystron tube shield, forming the top of the oscillator casting, is firmly in place.

WARNING

Application of power to this Tuning Unit results in very high voltages which are dangerous to life. Personnel must observe all safety precautions at all times. Do not attempt to remove the klystron tube from its cavity when operating power is applied.

(6) After connecting all cables to the tuning unit, throw the POWER switch on the Model LPU-1 Power Unit of the Spectrum Analyzer to its ON position. The tuning dial will be illuminated, and blower-motor operation will be heard. Proper functioning of the pilot lamps and the blower indicates the application of 6.3 and 115-volt a-c voltages to the equipment.

3. REPLACEMENT OF OSCILLATOR TUBE.
(Refer to figure 8).

a. A type RK-5721 tube is used as the reflex klystron oscillator in this Tuning

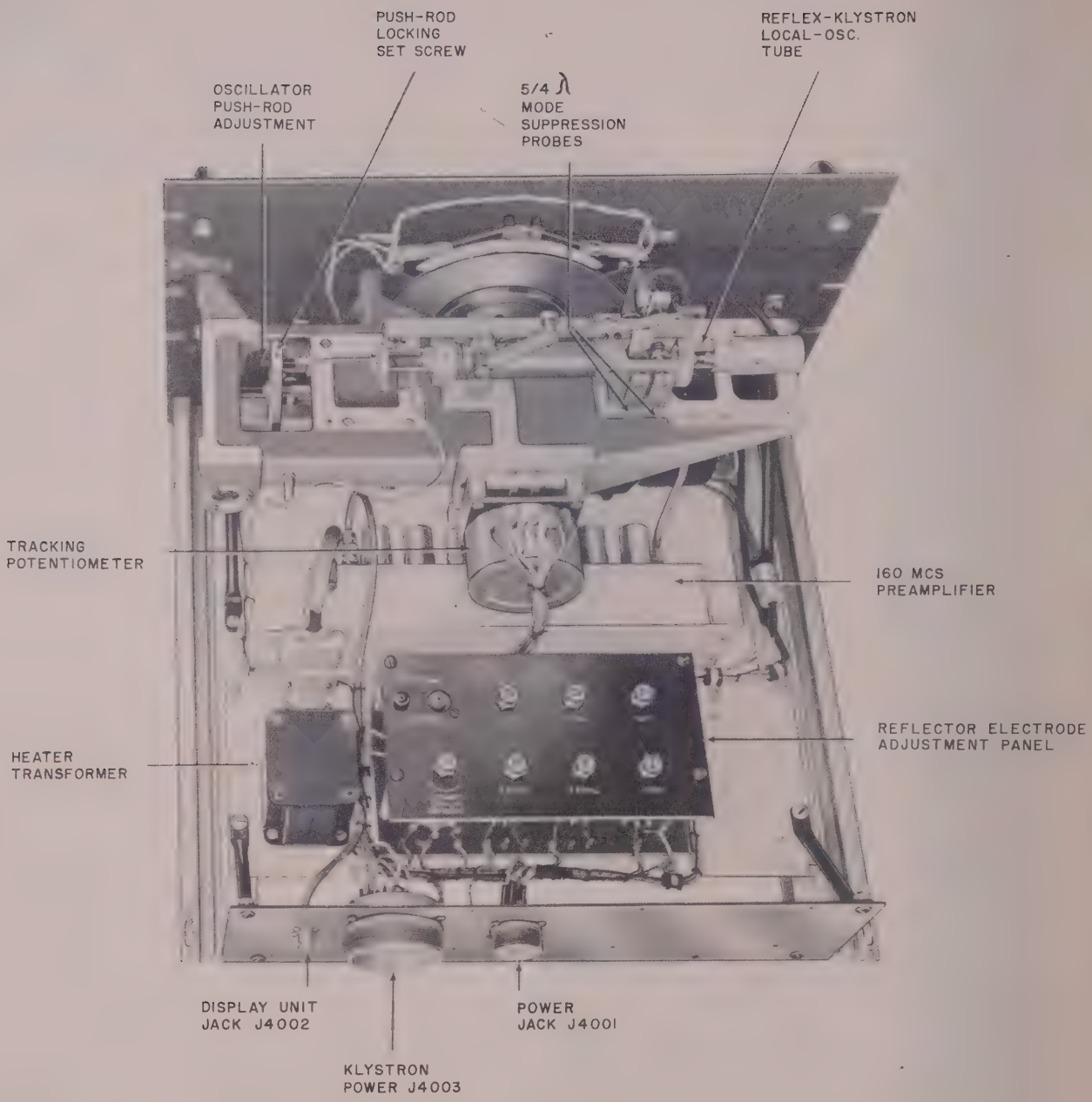


FIGURE 8. MODEL LTU-3 R-F TUNING UNIT, TOP VIEW.

Unit. The klystron tube is partially seated within the left end of the oscillator cavity, which is assembled on the casting directly to the rear of the equipment front panel. If replacement of the oscillator tube is necessary, proceed as follows:

(1) BE SURE TO TURN OPERATING POWER OFF. Throw the POWER switch on the Model LPU-1 Power Unit to the OFF position. In addition, remove Klystron Power Unit cable W4 from KLYSTRON POWER receptacle J4003 at the Tuning Unit rear panel. Also remove Power Unit cable W2 from POWER receptacle J4001 at the Tuning Unit rear panel.

(2) Remove the five No. 6-32 binding head screws which secure the protective shield to the oscillator casting. Three of the screws are located at the top of the casting, close to the equipment front panel; the other two screws are at the top rear edge of the casting. After removing the screws, lift the shield from the casting, so that the tube socket assembly and oscillator cavity are accessible.

(3) Gently pull the tube socket assembly away from the base of the klystron tube.

(4) Use the spanner wrench supplied with the equipment, to loosen the knurled collar at the end of the cavity.

(5) Grasp the projecting end of the klystron tube, gently rotating it in a clockwise direction, while simultaneously withdrawing the tube from its spring-finger holders within the cavity.

(6) Remove the banana jack, which is attached to the reflector electrode at the end opposite the base of the tube.

b. To insert a replacement type RK-5721 tube, known to be in good operating condition, into the cavity, proceed as directed below:

(1) Insert the banana jack, which is attached to the heavily-insulated high-voltage lead, into the reflector electrode connection at the end opposite the base of the tube.

(2) Gently push the klystron tube into the center of the cavity, and press it all the way in, against a noticeable resistance. (This resistance is an indication that the inner conductors of the cavity are sliding over the collar at the end of the tube). Continue pushing the tube into the cavity, giving the tube a slight clockwise twist, until it meets a positive stop.

(3) Re-tighten the knurled collar at the left end of the cavity, using the spanner wrench.

(4) Attach the socket assembly to the base of the replacement klystron tube.

NOTE

Carefully observe the arrangement of the four pins at the base of the tube, and the mating connectors on the tube socket. Do not use excessive force in connecting the socket to the klystron tube, since it is possible to force the socket assembly on to the base in a misaligned position. The klystron oscillator will be inoperative under this condition.

(5) Replace the protective shield over the top of the oscillator casting, using the five No. 6-32 binding head screws to secure the shield to the assembly.

(6) Connect Power Unit cable W2 to POWER receptacle J4001 on the equipment rear panel. Then connect Klystron Power Unit cable W4 to KLYSTRON POWER receptacle J4003, on the equipment rear panel. Throw the POWER switch on the Model LPU-1 Power Unit to its ON Position. Allow a ten-minute warm-up period. Then re-align the tuning unit, as directed below.

4. ALIGNMENT PROCEDURE.

The following table gives the alignment procedure, which is required after replacing a klystron local-oscillator tube in the Model LTU-3 RF Tuning Unit.

TABLE 3. Model LTU-3 TUNING UNIT ALIGNMENT PROCEDURE

Step	Adjustment	Adjustment Location	Proper Indication
1	Set POWER switch to OFF Position.	Front panel of Power Unit.	All pilots and tuning dial lights out.
2	Rotate the INCREASE CATHODE CURRENT screwdrive control to extreme counter-clockwise position.	Reflector control board, at rear of Tuning Unit.	None.
3	Set POWER switch to ON position, and wait approximately 1-minute for delay-relay in Klystron Power Unit to complete its cycle.	Front panel of Power Unit.	a. All pilots light. b. Meter pointer on Power Unit panel deflects to an on-scale indication, depending on position of METER SELECTOR. c. After the one-minute delay period, pointers of the three meters on the Klystron Power Unit panel deflect as given below: CATHODE CURRENT On scale. REFLECTOR VOLTAGE 600. ANODE VOLTAGE: 1000.
4	Rotate the INCREASE CATHODE CURRENT control Clockwise until pointer of CATHODE CURRENT meter indicates 22 ma. (Re-check and readjust, if necessary, after a 10-minute operating period.)	Reflector control board, at rear of Tuning Unit.	CATHODE CURRENT meter pointer remains at 22 ma. calibration mark. Pointer of CRYSTAL CURRENT meter on Spectrum Display Unit deflects to the right. NOTE A pointer deflection on the CRYSTAL CURRENT meter is an indication only that the klystron oscillator is functioning. Any pointer deflection is a sign of klystron output. Trouble-shooting of the equipment is required in the event that no CRYSTAL CURRENT meter indication is obtained and no IF output is observed.

TABLE 3. Model LTU-3 TUNING UNIT ALIGNMENT PROCEDURE
(continued)

Step	Adjustment	Adjustment Location	Proper Indication
5	Rotate the TUNING knob to the high-frequency end of the tuning dial.	Top center of Tuning Unit front panel.	8500 Mcs calibration mark, on the lower scale appears under the index hairline.
6	Connect the r-f output of a signal source, producing an un-modulated 8500-Mcs signal, into SIGNAL INPUT jack.	Left center section of Tuning Unit front panel.	A pip, corresponding in frequency to the r-f signal applied to the INPUT jack, appears on the screen of the Model LDU-1 Display Unit. If no pip is observed after performing step or if the pip is not centered on the screen, proceed as directed in steps 7 through 11. If the pip is centered on screen, skip to step 12.
7	Loosen the no. 6 spline-head set screw, which functions as a lock for the oscillator push-rod adjustment screw.	Top surface of trapezoidal-shaped plate, to the right of oscillator cavity.	None.
8	Slowly rotate the oscillator push-rod adjustment screw by means of a no. 1/4-28 Allen wrench first in one direction, then in the other direction, until the signal pip is centered on the screen of the Display Unit.	Aperture at right side of trapezoidal-shaped plate, to the right of oscillator cavity.	R-f signal pip moves across spectrum display.
9	Rotate the HIGH limit screwdriver control until maximum pointer deflection on the CRYSTAL CURRENT meter is obtained.	Reflector control board, rear of Tuning Unit.	CRYSTAL CURRENT meter, on Display Unit front panel, shows increased reading.
10	If step 9 causes the signal pip to shift from the center of the screen, re-trim the oscillator push-rod adjustment screw until the pip is re-centered. Then re-trim the setting of HIGH limit control until maximum swing of CRYSTAL CURRENT meter pointer is obtained.	a. Projecting Allen head screw at trapezoidal-plate aperture. b. Reflector control board, rear of Tuning Unit.	a. R-f signal pip moves across the display. b. Increased reading on CRYSTAL CURRENT meter.

TABLE 3. Model LTU-3 TUNING UNIT ALIGNMENT PROCEDURE
(continued)

Step	Adjustment	Adjustment Location	Proper Indication
11	After performing steps 8 and 9 as often as necessary until maximum CRYSTAL CURRENT meter indication occurs at the same time that the pip is centered on the screen, tighten the no. 6 splinehead set screw, which locks the oscillator pushrod adjustment screw.	Top surface of plate, to the right of the oscillator cavity.	Signal pip remains at the center of the display.
12	Rotate the TUNING knob to the low-frequency end of the tuning dial.	Center of Tuning Unit front panel.	4460 Mcs calibration mark, on the lower dial, appears under the index hairline.
13	Slowly rotate the LOW limit screwdriver control in a counterclockwise direction and observe the CRYSTAL CURRENT meter for an abrupt change (either an increase or decrease) in reading.	Reflector control board, rear of Tuning Unit.	Abrupt change in pointer deflection on CRYSTAL CURRENT meter.
14	Mark an index line (using a colored pencil or similar device), on the panel of the reflector control board, showing the orientation of the slot on the LOW control for step 13.	.....	Index mark on the panel lines up with position of LOW screwdriver slot.
15	Slowly rotate the LOW limit screwdriver control in a clockwise direction, and observe the CRYSTAL CURRENT meter for a second abrupt change in reading.	Reflector control board.	Second abrupt change in pointer deflection on CRYSTAL CURRENT meter.
16	Mark an index line on the panel of the reflector control board, showing	.....	Index mark on the panel lines up with second position of LOW screwdriver slot.

TABLE 3. Model LTU-3 TUNING UNIT ALIGNMENT PROCEDURE
(continued)

Step	Adjustment	Adjustment Location	Proper Indication
	the orientation of the slot on the LOW control for step 15.		
17	Rotate the LOW limit screwdriver control so that the slot at the top of its shaft is oriented midway between the two index marks inscribed after steps 13 and 15.	Reflector control board.	None.
18	Rotate the TUNING knob until the lower scale 5000-Mc calibration appears under the index hairline, and rotate the TRACK 1 screwdrive control shaft for maximum pointer deflection on CRYSTAL CURRENT meter.	Center of Tuning Unit front panel, and reflector control board.	5000 Mcs mark is under tuning dial hairline. Observe indication on CRYSTAL CURRENT meter.
19	Rotate the TUNING knob until the lower dial 5600-Mcs mark appears under the index hairline, and rotate the TRACK 2 screwdriver control shaft for maximum pointer deflection on CRYSTAL CURRENT meter.	Center of Tuning Unit front panel, and reflector control board.	5600 Mcs mark is under tuning dial hairline. Observe indication on CRYSTAL CURRENT meter.
20	Rotate the tuning knob until the lower dial 6300-Mcs mark appears under the index hairline, and rotate the TRACK 3 screwdriver control shaft for maximum pointer deflection on CRYSTAL CURRENT meter.	Center of Tuning Unit front panel, and reflector control board.	6300 Mcs mark is under tuning dial hairline. Observe indication on CRYSTAL CURRENT meter.
21	Rotate the TUNING knob until the lower dial 7200-Mcs mark appears under the index hairline,	Center of Tuning Unit front panel, and reflector control board.	7200 Mcs mark is under tuning dial hairline. Observe indication on CRYSTAL CURRENT meter.

TABLE 3. Model LTU-3 TUNING UNIT ALIGNMENT PROCEDURE
(continued)

Step	Adjustment	Adjustment Location	Proper Indication
	and rotate the TRACK 4 screwdriver control shaft for maximum pointer deflection on CRYSTAL CURRENT meter.		
22	Tune the unit to 8500 Mcs, and readjust the HIGH limit screwdriver control shaft for maximum pointer deflection on CRYSTAL CURRENT meter.	Reflector control board.	8500 Mcs, mark is under tuning dial hairline. Observe indication on CRYSTAL CURRENT meter.
23	Re-check steps 12 through 22 and readjust if subsequent tracking control settings have disturbed maximum CRYSTAL CURRENT indications of earlier adjustments.	Reflector control board.	See steps 12 through 22 above.
24	With the RF attenuator (supplied with the equipment) connected between the signal source and the SIGNAL INPUT jack, swing the tuning dial throughout its range while observing the variations in pointer deflection on the CRYSTAL CURRENT meter. Then set the screwdriver adjusted XTAL CURRENT LIMIT control R4020 for maximum meter indication of 3 milliamperes.	Right section of Tuning Unit chassis, directly in front of heater transformer T4001, as viewed from the front of the equipment.	CRYSTAL CURRENT meter maximum indication is 3.0 ma., as the complete range of the tuning dial is covered.

5. PREAMPLIFIER ALIGNMENT.

a. The preamplifier of the Model LTU-3 Tuning Unit is located beneath the oscillator cavity, and is positioned with the tubes in a horizontal plane for ease of accessibility. The preamplifier sub-chassis is supported by a metal flat plate, which is secured to an aluminum angle extending across the side legs of the main frame, by means of mounting screws. To remove the preamplifier sub-chassis for alignment, unscrew the four mounting screws (two at each side) which hold the mounting feet of the sub-chassis to the metal angle and plate. Disconnect the RG-71/U cable termination, P4008, from the XTAL MIXER INPUT receptable J4008, on the top left side of the sub-chassis. Do not remove the other cable connections. Proceed as directed below:

(1) Use a signal generator within the frequency range from 146 Mcs to 175 Mcs as the signal source.

(2) Connect the output cable of the signal generator through a suitable pad (providing at least 6 db attenuation) directly into the XTAL MIXER INPUT jack J4008, located at the top left side of the preamplifier.

(3) Be sure that the multi-conductor cable terminating in plug P4007 is making good electrical contact with the vertically mounted receptacle J4007, located below and to the right of the oscillator casting. Also check that inter-unit cable W5 connects the signal output at DISPLAY UNIT jack J4002, on the rear panel, to TUNING HEAD jack J302, on the Spectrum Display Unit. With the cables connected as directed, align the preamplifier by observing the signal pip on the screen of the Display Unit.

(4) If desired, an r-f voltmeter may be used as the indicating device in this alignment procedure, instead of utilizing the spectrum display. In this case, disconnect cable W5 from the DISPLAY UNIT jack J4002. Connect the r-f voltmeter to J4002 through a 50-ohm terminated cable.

NOTE

If an r-f voltmeter is used at the output of the preamplifier, vary the signal generator output lever control so that a voltmeter indication no greater than 0.4 volt is obtained throughout the alignment procedure.

b. STEP-BY-STEP PROCEDURE: -- Allow the signal generator and the preamplifier a 10-minute warm-up period; then follow the steps outlined immediately below:

(1) Set the controls on the signal generator to produce a cw signal of 146 Mcs, and tune the two adjustment screws marked 146 Mc (L1304 and L1307) until maximum output is obtained on the spectrum display screen, or on the r-f voltmeter.

(2) Set the controls on the signal generator to produce a cw output frequency of 175 Mcs, and tune the two adjustment screws marked 175 Mc (for L1303 and L1306) until maximum output is obtained.

(3) Set the controls on the signal generator to produce a cw output frequency of 160 Mcs, and tune two of the three adjustment screws marked 160 Mc (for L1302 and L1305) until maximum output is obtained. The adjustment screw for L4001, located to the left of the first amplifier tube V1301, as viewed from the top of the sub-chassis, is adjusted as directed in step (5) below.

(4) After completing steps (1) through (3) above, the preamplifier preliminary alignment is completed. For optimum adjustment, however, its response should be checked. Construct a response curve, by varying the output of the signal generator over the range from 146 to 175 Mc, noting the output voltage at several frequencies. If necessary, slightly re-tune the 160 Mcs inductors L1302 and L1305. At the 3 db points, the bandwidth of the preamplifier is approximately 28 Mc, with a voltage gain of approximately 10 (20 db), for an input signal of 0.02 volt.

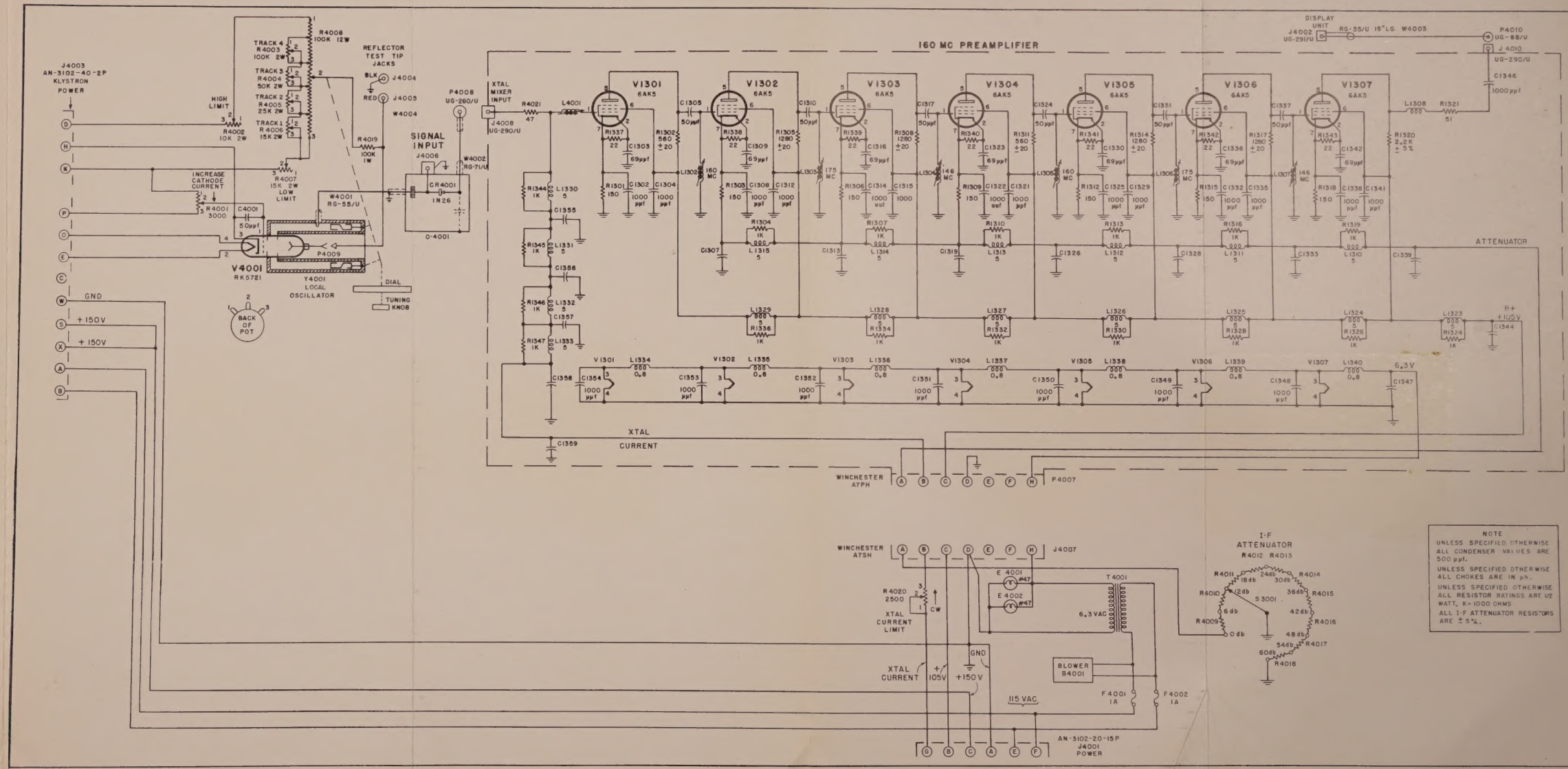
(5) To tune input inductor L4001, in the grid circuit of the first amplifier tube V1301, disconnect the signal generator output cable from XTAL MIXER INPUT jack J4008 and re-connect coaxial cable W4002 from the crystal mixer assembly 0-4001 to the XTAL MIXER INPUT jack. Apply a test signal to the Tuning Unit through the external RF attenuator if the signal power level is greater than 1 milliwatt, and rotate the TUNING dial to the same frequency as the signal source. Rock the TUNING dial until the pip representing the detected test signal appears at the center of the Spectrum Display Unit screen. Tune the variable input inductor L4001 critically by rocking its adjustment screw until the maximum height of the signal on the screen is obtained.

NOTES

1. An I-F Attenuation table is provided with each Model LTU-3 RF Tuning Unit supplied.

2. A Correction Chart for the tuning dial calibration is provided with each Model LTU-3 RF Tuning Unit supplied.

NOTE 3: Blower motor requires oiling every three (3) months with SAE-20 in two oil holes provided.



POLARAD ELECTRONICS CORP.

TUNING UNIT (PART OF SPECTRUM ANALYZER) SCHEMATIC
DIAGRAM 4460-16,520MC, MODEL LTU-3.

Figure 9